

Pipeline Research & Development Forum Facilities Track Summary: Prime Movers

| Identified Challenges | R&D Opportunities | Why Worth Pursuing |
|--|---|--|
| <p>Lower Emissions</p> <ul style="list-style-type: none"> • Compliance with tightening air quality standards NOx, SOx, PM2.5, 8 hr standard (see Sam), • R&D that allows industry to comply with standards or show can not comply/reg not reasonable • Monitoring emissions and making sure equipment accurate • Lower emission technologies are not effective over entire range of operations • How do we quantify fugitive emissions of CO2, methane | <ol style="list-style-type: none"> 1. NOx: Research that will allow us to get to .15g NOx for engines, 15ppm NOx for turbines over entire range of operations 2. HAPs: Lower formaldehyde 93ppb (turbines), engines 100ppb 3. Inexpensive monitoring technologies | <ol style="list-style-type: none"> 1. Mandates |

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| <p>1. Increase net energy efficiency at compressor stations</p> <ul style="list-style-type: none"> • Energy conservation & efficiency of site in its entirety, including auxiliaries & hydraulic efficiencies • With increasing cost of gas, need to improve economics (bottom line effect) • Blow downs, operational leaks (intended/non-intended), loss of gas from wellhead to burner • System optimization | <ol style="list-style-type: none"> 1. Research that will increase the net energy efficiency at the prime mover, compressor and all of the plumbing 2. Tools to accurately identify and quantify fugitive emissions 3. Technologies to eliminate fugitive emissions 4. Research that will optimize system performance through integration of modeling and sensor technologies | <ol style="list-style-type: none"> 1. Emissions improvements 2. Cost reductions 3. Improved deliverability 4. Reduce cost of service |

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Facilities Track Summary: Metering and Measurement

| Identified Challenges | R&D Opportunities | Why Worth Pursuing |
|---|--|--|
| 1. Maintain Measurement/ Other Standards | 1. Research to evaluate existing and evolving metering technology as basis for new standards or to revise existing standards 2. Technical justification for international standardization | 1. Supports commercial transactions 2. Avoids custody transfer disputes 3. Instills customer confidence |

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Facilities Track Summary: Metering and Measurement

| Identified Challenges | R&D Opportunities | Why Worth Pursuing |
|--|---|---|
| 1. Development of new metering technology | 1. Continued R&D into ultrasonic, coriolis, and other evolving technologies 2. Complete the development of energy meter and transfer technology 3. ID ways to measure fluid quality more cost effectively and in real time 4. Multiphase measurement | 1. More cost effective real time measurement 2. Avoids problems associated with product contamination and system integrity |

Pipeline Research & Development Forum Facilities Track Summary: Storage

| Identified Challenges | R&D Opportunities | Why Worth Pursuing |
|---|---|--|
| 1. Enhanced deliverability from current infrastructure (compression, storage, metering, etc) | 1. Opportunity map to define priorities – across the board assessment of entire infrastructure (planning groups to work with the R&D groups) 2. Continue to support existing programs that improve deliverability through compression, storage and metering efficiencies | 1. Market demands increasing 2. Need big picture view to better ID where additional R&D is needed 3. Reduce new infrastructure investments/ siting issues |

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Facilities Track Summary: Storage

| Identified Challenges | R&D Opportunities | Why Worth Pursuing |
|--|--|---|
| 1. Exploration of new storage options | 1. Innovative market area storage 2. Efficiencies in LNG development for peak shaving applications 3. R&D that will reduce the cost of building peak shaving facilities (hydrates, etc) | 1. Least cost deliverability 2. Increasing demand and local demand 3. Optimize system efficiencies and flexibility |

Final Challenge

**Facilities issues are orphaned –
They do not receive the R&D
resources that are needed to allow
the industry to meet future demands**